

Prepared for:

SOUTHERN CALIFORNIA CHEMICAL
Santa Fe Springs, California

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**ASSESSMENT OF GROUNDWATER
CONTAMINATION POTENTIAL**
*Proposed Ferric Chloride Process
Rehabilitation Area*

MARCH 9, 1990

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INTRODUCTION

Southern California Chemical (SCC) has operated an inorganic chemical manufacturing and recycling facility at 8851 Dice Road in Santa Fe Springs, California since 1957. The company receives aqueous hazardous wastes, in large part from the aerospace and electronics industries. These wastes are treated for disposal to the sanitary sewer or Class I Hazardous Waste Landfills. During the treatment process, recyclable materials in the wastes are recovered and further processed for resale. In addition, chemicals are manufactured from virgin materials for sale.

One of the remaining original chemical recycling processes at the facility is ferric chloride recovery and production. Spent ferric chloride is received as a waste material and regenerated by precipitation of the copper and heavy metal contaminants. The resulting ferrous chloride solution is sold or further treated by chlorination to produce ferric chloride for sale. The copper and heavy metal by-products are sold to smelters for recovery and resale. This process currently treats approximately 25 percent of the hazardous wastes received by Southern California Chemical.

In the consent agreement between the Department of Health Services (DHS) and SCC signed 8/28/87, Section 3.1.10 directs that SCC must immediately minimize the possibility of hazardous waste releases by repairing and replacing leaking tanks and containment areas. It was determined that the ferric chloride recovery process area qualified for action under this directive. Both its age and the corrosive chemicals handled during the process have resulted in gradual deterioration of the process equipment and area. Although SCC initiated a plan for corrective action and purchased replacement tanks as long ago as November, 1987, the ferric chloride process has not yet been upgraded to comply with the consent agreement.

Delays in obtaining local permits, required modifications to the RCRA Part A application and concerns about soil contamination at the proposed rehabilitation area have impeded SCC's progress in addressing the release hazards associated with the ferric chloride process area. A number of rehabilitation alternatives have been developed and proposed to the

regulatory agencies. At present, the conceptually approved rehabilitation plan involves replacement of the deteriorated equipment and relocation of the process to a 4200 square-foot unpaved area west of the current process area. Implementation of the corrective action will occur as soon as approval by the regulatory agencies is received.

In a meeting between SCC, Camp Dresser & McKee (CDM), DHS and the EPA on November 29, 1989, this situation was discussed in detail. The primary concern was the potential impact on groundwater if metals constituents were allowed to remain in the unsaturated zone soils. It was decided that a pre-RFI soil investigation of the proposed rehabilitation area would be conducted to supplement existing soil analytical data. Prompt consideration of the results and a decision concerning the requirements for the proposed rehabilitation of the process were promised by both the EPA and the DHS. The purpose of this report is to evaluate the potential for groundwater contamination associated with rehabilitation of the ferric chloride process without remediation of the soils at the proposed location.

SITE CHARACTERIZATION

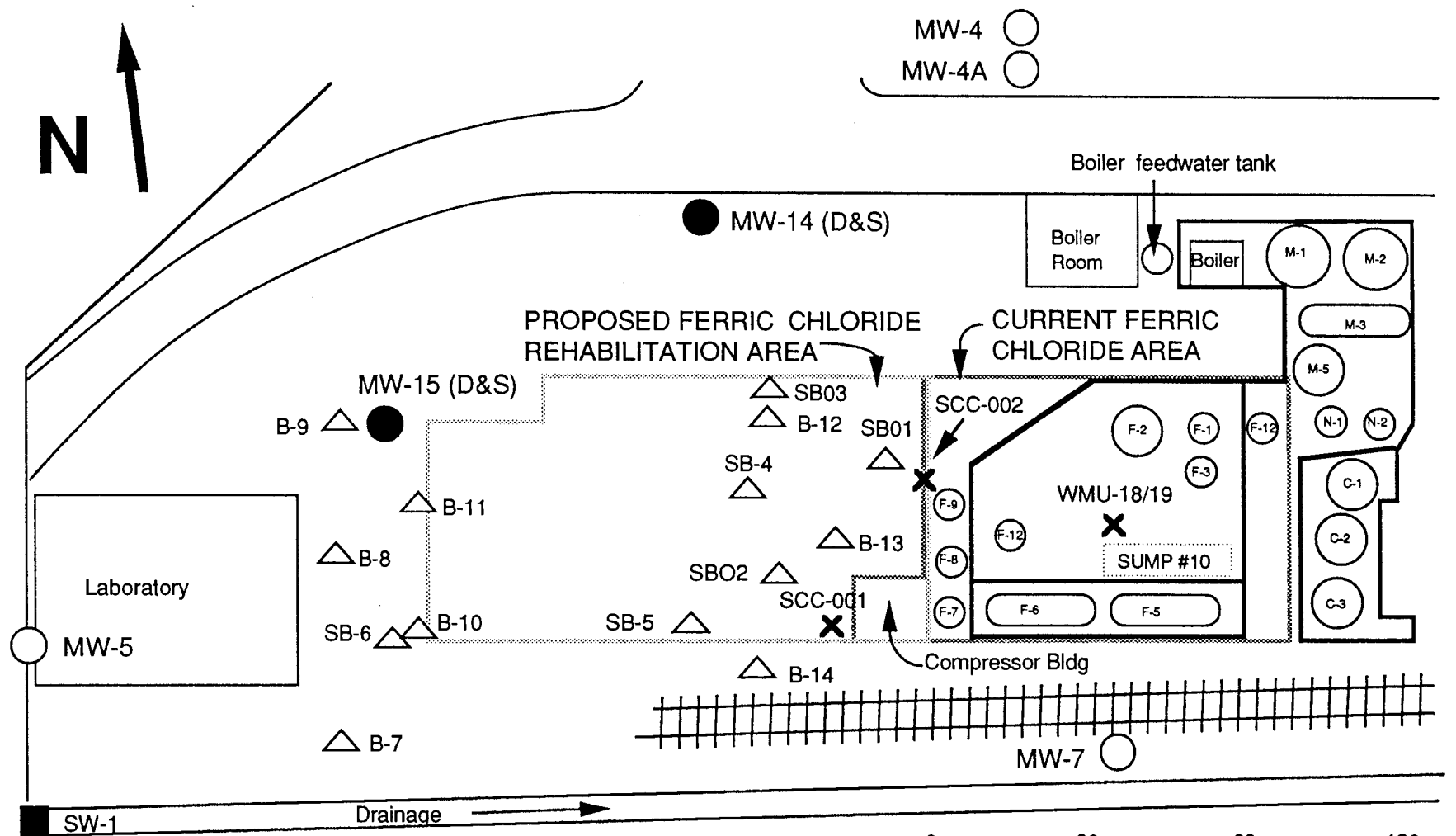
Soils

A number of soils investigations at the proposed ferric chloride rehabilitation area have been conducted to date. Figure 1 depicts the sampling locations and the soil analytical results are presented in Table 1. A total of 60 samples were collected and analyzed for total chromium, and at least 40 samples were collected and analyzed for cadmium, hexavalent chromium, copper, lead, nickel and zinc. Metals contamination of the site does exist, and it varies widely laterally and with depth. The highest metals concentrations tend to exist in discrete zones and as a result the majority of samples exhibit concentrations which are lower than the mean concentration of each metal.

There are two characteristics associated with the contaminated soil which reduce the potential for mobility of the metals. SCC employees report that the top eight feet of soil at the rehabilitation area was stabilized with lime in the past. Base metals would likely be immobilized by the high pH and exhibit very little leaching to deeper soil. The low pH that exists at depth probably has reduced the mobility of acid metals such as arsenic and chromium. In addition, both acid and base metals exhibit poor mobility when the contamination is old (Bohn, 1985). This results from diffusion of the metallic ions to the strongest soil sorptive sites over time. Metals contamination existing under these conditions, therefore, would be expected to be fairly unavailable for leaching to groundwater.

Groundwater

In August of 1985, aquifer pumping tests were conducted by Kleinfelder, Inc. to determine the hydrological parameters affecting groundwater flow beneath the SCC facility. The results of these tests are listed in Table 2 and the calculation of pertinent hydrologic parameters from them is presented in Appendix A. The direction of groundwater flow was determined by Kleinfelder and confirmed by CDM investigations to be in a north, northeast to south, southwest orientation. Currently available information



LEGEND	
	Proposed Boring Location
	Proposed Monitoring Well Location (D-deep, S-Shallow)
	Proposed Surface Soil Sample Location
	Proposed Surface Water Sample Location
	Existing Soil Boring
	Existing Monitoring Well

03060120

SCALE (Feet)

Southern California Chemical	
FERRIC CHLORIDE AREA	
Camp Dresser & McKee CDM	Figure 1

TABLE 1
SUMMARY OF SOIL METALS CONCENTRATIONS
PROPOSED FERRIC CHLORIDE REHABILITATION AREA
SOUTHERN CALIFORNIA CHEMICAL COMPANY
(Concentrations in mg/kg)

Sample Location	Depth (ft)	Date	Antimony	Arsenic	Barium	Cadmium	Chromium (Hex)	Chromium (Total)	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
BORINGS																
B-7	5	Sep-88	4.00	4.00		0.86		537.00	206.00	17.00	0.02	19.00	ND	0.13	ND	169.00
	20	Sep-88	7.00	2.10		0.70		360.00	56.00	15.00	ND	11.00	ND	ND	ND	23.00
B-8	5	Sep-88	3.00	8.00		1.10		421.00	502.00	134.00	0.04	24.00	ND	0.34	ND	400.00
	20	Sep-88	ND	2.40		0.45		17.00	56.00	8.23	ND	8.13	ND	ND	ND	25.00
B-9	5	Sep-88	2.00	4.00		1.50		181.00	233.00	85.00	0.03	19.00	ND	0.11	ND	116.00
	20	Sep-88	ND	4.80		0.31		8.57	8.60	2.85	ND	6.84	ND	ND	ND	21.00
B-10	5	Sep-88	11.00	10.00		1.70		573.00	408.00	124.00	0.07	43.00	ND	0.30	ND	392.00
	20	Sep-88	4.00	4.00		0.30		8.37	46.00	4.13	ND	7.89	ND	0.10	ND	28.00
B-11	5	Sep-88	ND	4.10		2.10		18.00	15.00	6.48	0.03	112.00	ND	ND	ND	415.00
	20	Sep-88	ND	5.00		0.51		10.00	9.42	3.55	ND	7.97	ND	ND	ND	24.00
B-12	5	Sep-88	ND	62.00		0.70		20.00	18.00	7.28	0.04	14.00	ND	ND	ND	39.00
	20	Sep-88	ND	6.20		0.31		9.48	9.75	3.00	0.03	7.47	ND	ND	ND	25.00
B-13	5	Sep-88	11.00	17.00		2.00		814.00	433.00	390.00	0.04	42.00	ND	ND	ND	508.00
	20	Sep-88	2.00	4.00		0.28		62.00	34.00	356.00	ND	7.72	ND	ND	ND	23.00
B-14	5	Sep-88	17.00	11.00		3.70		796.00	424.00	1110.00	0.06	49.00	ND	0.60	ND	617.00
	20	Sep-88	6.00	4.00		0.37		346.00	20.00	3.78	ND	7.48	ND	ND	ND	41.00
SB01	5	Apr-89					0.11	440.00								
	10	Apr-89					0.11	24.00								
	15	Apr-89					< 0.10	9.88								
	20	Apr-89					< 0.10	6.06								
	25	Apr-89					< 0.10	10.90								
SB02	5	Apr-89					0.51	788.00								
	11	Apr-89					< 0.10	21.50								
	15	Apr-89					< 0.10	6.43								
	20	Apr-89					< 0.10	5.68								
	25	Apr-89					4.49	521.00								
SB03	5	Apr-89					< 0.10	441.00								
	10	Apr-89					< 0.10	20.50								
	15	Apr-89					< 0.10	7.33								
	20	Apr-89					3.47	42.20								
	25	Apr-89					126.00	918.00								
	30	Apr-89					45.00	1430.00								
SCC-SB04	6	Dec-89				0.30	< 1.00	65.00	120.00	29.00		12.00				59.00
	16	Dec-89				0.10	12.20	160.00	33.00	2.00		8.10				25.00
	21	Dec-89				0.13	12.60	120.00	27.00	0.84		6.90				22.00
	25.5	Dec-89				0.07	51.10	400.00	32.00	1.00		6.20				16.00
	31	Dec-89				0.06	11.90	810.00	94.00	1.70		11.00				30.00
	36	Dec-89				0.07	11.80	80.00	90.00	0.66		7.20				16.00
	49	Dec-89				0.25	26.90	75.00	720.00	0.85		41.00				81.00
SCC-SB05	5.5	Dec-89				1.30	< 1.00	400.00	520.00	110.00		46.00				380.00
	10.5	Dec-89				< 0.50	4.47	720.00	47.00	2.70		9.90				120.00
	15.5	Dec-89				< 0.50	7.27	1200.00	57.00	3.10		12.00				190.00
	20.5	Dec-89				< 0.50	2.68	410.00	57.00	2.00		11.00				240.00
	25.5	Dec-89				< 0.50	3.65	920.00	160.00	3.00		20.00				260.00
	30	Dec-89				0.50	3.02	350.00	160.00	3.60		24.00				360.00
	35.5	Dec-89				0.10	< 1.00	110.00	40.00	0.94		6.00				68.00
	45.5	Dec-89				< 0.50	3.26	220.00	120.00	4.40		13.00				40.00
SCC-SB06	6	Dec-89				0.80	1.84	310.00	230.00	58.00		24.00				130.00
	11	Dec-89				1.30	< 1.00	940.00	140.00	8.50		22.00				36.00
	15.5	Dec-89				0.30	< 1.00	280.00	23.00	2.80		5.00				8.20
	21	Dec-89				0.18	< 1.00	46.00	15.00	3.30		3.00				4.70
	25.5	Dec-89				0.30	< 1.00	48.00	22.00	5.10		4.30				4.50
	31	Dec-89				0.37	< 1.00	44.00	280.00	3.70		55.00				41.00
	37	Dec-89				0.12	< 1.00	7.00	29.00	0.87		5.80				10.00
	46	Dec-89				0.13	< 1.00	6.00	64.00	12.00		15.00				19.00
MONITORING WELLS																
MW-5	10	Jan-85						5.90	36.00			6.60				38.00
	30	Jan-85						5.50	17.00			5.10				22.00
MW-7	35	Jul-85				0.59		35.00	46.00							77.00
DHS LOCATIONS																
SCC-001	SURFACE	May-89			150.00		< 0.40	1500.00	4400.00	560.00		130.00				1100.00
SCC-002	SURFACE	May-89			< 50.00		< 0.40	630.00	150.00	120.00		420.00				190.00
SUMMARY																
NUMBER OF VALUES			10.00	16.00	2.00	40.00	41.00	60.00	44.00	41.00	9.00	43.00		6.00		44.00
MEAN CONCENTRATION			6.70	9.54	100.00	0.66	8.39	312.86	231.99	78.30	0.04	30.62	ND	0.26	ND	146.67
MAXIMUM CONCENTRATION			17.00	62.00	150.00	3.70	126.00	1500.00	4400.00	1110.00	0.07	420.00	ND	0.60	ND	1100.00
MINIMUM CONCENTRATION			2.00	2.10	50.00	0.06	0.10	5.50	8.60	0.66	0.02	3.00	ND	0.10	ND	4.50

TABLE 2
HYDROLOGIC PARAMETERS (1)
PROPOSED FERRIC CHLORIDE RELOCATION SITE
SOUTHERN CALIFORNIA CHEMICAL

	Transmissivity (gpd/ft)	Groundwater Elevation (ft)
Monitoring Well 4	42,990	105.16
	36,246	
Monitoring Well 8	41,250	106.86
	44,694	
	42,984	
Monitoring Well 10	32,057	106.94
	42,710	
	34,930	
Average	39,733	

1 Kleinfelder, 1986

indicates that the depth from soil surface to groundwater is 55 feet and that the aquifer is semi-confined.

Groundwater monitoring has been conducted at the SCC facility since February, 1985, in accordance with RCRA requirements for detection and assessment monitoring. Monitoring well locations are shown in Figure 1. Inorganic constituents, varying in concentration and lateral extent over time, have been identified in the area of monitoring well 4, (CDM, 1989). This well is located roughly upgradient, and monitoring wells 5 and 7 are located downgradient from the proposed rehabilitation area. The analytical data from groundwater samples collected to date from these three wells are presented in Table 3. The absence of groundwater contamination in the downgradient monitoring wells 5 and 7 indicate that neither the upgradient groundwater contamination nor the soils contamination in the proposed rehabilitation area are migrating with groundwater flow off the property.

Use

Southern California Chemical operates on 4.8 acres in a highly industrialized area of Santa Fe Springs. There are other industrial facilities located to the north, east and west of SCC, and railroad tracks border the north, west and south property lines. As a result, it may be concluded that the current and long term intended use of the site is industrial. Due to zoning restrictions in the area, it is unlikely that future use of the site, or areas adjacent to the site would ever be residential. At present, the nearest residential area is approximately 1000 feet to the north of SCC's property.

TABLE 3
SUMMARY OF GROUNDWATER METALS CONCENTRATIONS
SOUTHERN CALIFORNIA CHEMICAL COMPANY
(Concentrations in mg/L)

Date	Monitoring Well 4					Monitoring Well 5					Monitoring Well 7				
	Cadmium	Chromium (Hex)	Chromium (Total)	Copper	Zinc	Cadmium	Chromium (Hex)	Chromium (Total)	Copper	Zinc	Cadmium	Chromium (Hex)	Chromium (Total)	Copper	Zinc
Feb-85		500	500	< 0.08		< 0.0002	< 0.05	< 0.0005	< 0.08	< 0.019					
Jul-85	< 0.01	500	550								< 0.01	< 0.5	< 0.03		
Mar-86	< 0.01		61	< 0.02	< 0.03	< 0.009	< 0.02	< 0.03	< 0.02	0.18	< 0.009	< 0.02	< 0.03	< 0.02	< 0.03
Jul-86	< 0.01	120	120	< 0.02	< 0.04	< 0.01	< 0.02	< 0.03	< 0.02	< 0.04	< 0.01	< 0.02	< 0.03	< 0.02	< 0.04
Sep-86	< 0.01	180	180	< 0.04	< 0.08	< 0.01	< 0.02	< 0.03	< 0.04	< 0.08	< 0.01	< 0.02	< 0.03	< 0.04	< 0.04
Dec-86	< 0.01	170	170	< 0.03	< 0.007	< 0.01	< 0.02	< 0.03	< 0.04	< 0.001	< 0.01	< 0.02	< 0.03	< 0.03	0.022
Mar-87		100	98	< 0.02		< 0.01	< 0.02	< 0.04	< 0.02	< 0.031	< 0.01	< 0.02	< 0.04	< 0.02	< 0.03
Jun-87	< 0.01	430	440	< 0.02	< 0.03	< 0.01	< 0.02	< 0.04	< 0.02	< 0.03	< 0.01	< 0.02	< 0.04	0.08	0.04
Oct-87	< 0.02	232	190	< 0.02	< 0.03	< 0.02	< 0.02	< 0.04	< 0.02	< 0.03	< 0.02	< 0.02	< 0.04	< 0.02	< 0.03
Feb-88	< 0.02	140	140	< 0.03	< 0.02	< 0.02	< 0.1	0.1	< 0.02	0.4	< 0.02	< 0.1	0.02	< 0.02	< 0.02
May-88			238					< 0.02					< 0.02		
Jun-88	< 0.01	84	218	< 0.04	< 0.02	< 0.01	< 0.1	0.05	< 0.02	< 0.02	< 0.01	< 0.1	0.07	< 0.02	< 0.02
Sep-88	< 0.01	170	180	< 0.02	< 0.02	< 0.01	< 0.05	0.05	< 0.02	< 0.02	< 0.01	< 0.05	0.04	< 0.02	< 0.02
Jan-89	0.028	33	400	< 0.009	0.007	< 0.003	< 0.01	< 0.014	< 0.009	< 0.006	< 0.003	< 0.01	< 0.014	< 0.009	< 0.006
Apr-89	0.05	43	100	0.02	< 0.02	< 0.01	< 0.05	0.04	< 0.02	< 0.02	< 0.01	< 0.01	0.02	< 0.02	< 0.02
Jul-89	0.08	120	98	0.06	0.09	< 0.01	< 0.05	0.04	< 0.05	0.09	< 0.01	< 0.05	0.03	< 0.05	< 0.04
NUMBER OF VALUES	13.00	14.00	16.00	14.00	12.00	14.00	14.00	15.00	14.00	14.00	14.00	14.00	15.00	13.00	13.00
AVERAGE CONCENTRATION	0.02	201.57	230.19	0.03	0.03	ND	ND	0.04	ND	ND	ND	0.07	0.03	0.03	0.03
MAXIMUM CONCENTRATION	0.08	500.00	550.00	0.08	0.09	ND	ND	0.10	ND	ND	ND	0.50	0.07	0.08	0.04
MINIMUM CONCENTRATION	0.01	33.00	61.00	0.01	0.01	ND	ND	0.00	ND	ND	ND	0.01	0.01	0.01	0.01

POTENTIAL FOR GROUNDWATER CONTAMINATION

An evaluation of the potential for groundwater contamination involves determining the amount of soil contamination that may be expected to leach to groundwater under normal site conditions. This determination is based on the soil concentration of the metal, the partitioning of each metal between soil and water, the amount of percolating water that is available for leaching, and the volume of groundwater that the contaminated percolation enters.

A total of 4200 square-feet of aquifer may be impacted by the soil contamination at the proposed ferric chloride process rehabilitation area. In order to facilitate calculations, a one-square-foot unit of the aquifer will be considered. The impact of soil contamination on the aquifer unit is then assumed to be representative of all of the 4200 one-square-foot aquifer units. To justify this approach, soil and aquifer conditions are considered to be consistent over the volumes evaluated.

Mass Balance

A mass balance approach for one square foot of impacted aquifer over a year will be used for this site:

$$\text{Mass gw-i} = \text{Mass gw-u} + \text{Mass p}$$

Where: Mass gw-i = Mass metals in aquifer unit impacted by percolation
 Mass gw-u = Mass metals in upgradient aquifer
 Mass p = Mass metals in soil percolation

The mass of metal reaching the aquifer upgradient of the site is assumed to be zero. The mass of each metal in the aquifer unit impacted by percolation is then equal to the mass of metal in the infiltration exposed to contaminated soil. This assumes instantaneous mixing of the percolation over the depth of the aquifer unit. Substituting concentration and volume for mass yields:

$$(\text{Conc p}) * (\text{Vol p}) = (\text{Conc gw-i}) * (\text{Vol gw-i})$$

where: Conc p = Concentration metal in percolation (mg/L)
 Vol p = Volume of percolation per year (ft³/yr)
 Conc gw-i = Concentration metal in aquifer unit impacted by
 percolation (mg/L)
 Vol gw-i = Volume of aquifer unit impacted by percolation
 per year (ft³/yr)

Percolation Concentration

The transfer of a metal associated with the soil to percolation is dependent on a number of metal specific factors. These are represented by a distribution coefficient (Kd) for each metal in the particular soil and water environment it exists in. This coefficient may be used in a direct calculation of the concentration of the metal in the water phase if the soil concentration is known, and vice versa:

$$Kd = \text{Conc s} / \text{Conc p}$$

Where: Conc s = Concentration metal in soil (mg/Kg)

Because site specific Kd values are not available for the proposed rehabilitation area, Kd values found in the literature were used. At least four references were obtained for each metal, the lowest percolation concentration calculated from the Kd values was dropped and the remaining concentrations were averaged. Use of the distribution coefficient assumes that the system is in equilibrium and reactions are reversible and fast.

Percolation Volume

Percolation was assumed to be equal to the infiltration of rainfall. Calculation of infiltration is based on an average yearly rainfall for the area of 14 inches (RWQCB, 1986):

$$N = 0.9(R - R_o) \text{ (Brocard, 1988)}$$

Where: N = Infiltration (in)
R = Annual rainfall (in)
Ro = Rainfall Threshold = 7.874 inches

The volume of percolation that will impact the aquifer unit is then determined from the infiltration over the aquifer unit surface area:

$$\text{Vol p} = (N / 12\text{in/foot}) * 1 \text{ ft}^2$$

Impacted Aquifer Volume

The volume of the aquifer unit impacted by percolation over a year is assumed to be equal to the sum of the volume of the aquifer unit exposed to percolation and the percolation volume:

$$\text{Vol gw-i} = \text{Vol gw} + \text{Vol p}$$

Where: Vol gw = Volume aquifer unit exposed to percolation per year (ft³/yr)

The volume of the aquifer unit being exposed to percolation is determined from the distance the groundwater will travel in a year over the cross sectional area of the aquifer unit:

$$\text{Vol gw} = q * 365 \text{ days/year} * b * 1 \text{ ft}$$

Where: q = Specific discharge of the aquifer (ft/day)
b = Aquifer thickness (ft)

The specific discharge was calculated from the hydrologic data collected in August, 1985, and these calculations are shown in Appendix A.

Impacted Aquifer Concentration

The yearly increase in concentration of each metal in the aquifer unit as a result of contact with the contaminated percolation is shown in Table 4 and calculated as follows:

$$\text{Conc gw-i} = (\text{Vol p} * \text{Conc p}) / (\text{Vol gw-i})$$

The concentration of metals in impacted groundwater was calculated using the maximum soil concentrations. The groundwater concentrations listed would result, therefore, if the entire rehabilitation area exhibited these maximum soil concentrations. The soil data collected to date have varied widely, and average soil concentrations are in most cases ten-fold less than the maximum. The groundwater concentrations in Table 4, therefore, represent the maximum possible contamination that might occur if the rehabilitation area soil was not remediated.

TABLE 4
YEARLY INFLUENCE OF SOIL CONTAMINATION ON GROUNDWATER
PROPOSED FERRIC CHLORIDE REHABILITATION AREA
SOUTHERN CALIFORNIA CHEMICAL

Parameter	Maximum Soil Concentration (mg/Kg)	Kd Reference Values	Percolation Concentration (mg/L)	Average Percolation Concentration (1) (mg/L)	Increase in Downgradient Aquifer Concentration (2,3) (mg/L)
Maximum As	62.00	100	0.62	46.75	0.00
		5.86	10.58		
		19.5	3.18		
		$34C^{0.452}$	21.34		
		$5.37C^{0.487}$	151.90		
Average As	9.54	100	0.10	1.37	0.00
		5.86	1.63		
		19.5	0.49		
		$34C^{0.452}$	0.06		
		$5.37C^{0.487}$	3.25		
Maximum Cr (Tot)	1500	30	50.00	633.40	0.01
		3.5	428.57		
		1.8	833.33		
		2.35	638.30		
Average Cr (Tot)	312.86	30	10.43	132.11	0.00
		3.5	89.39		
		1.8	173.81		
		2.35	133.13		
Maximum Cr (Hex)	126.00	30	4.20	53.21	0.00
		3.5	36.00		
		1.8	70.00		
		2.35	53.62		
Average Cr (Hex)	8.39	30	0.28	3.54	0.00
		3.5	2.40		
		1.8	4.66		
		2.35	3.57		
Maximum Cu	4400	41.9	105.01	309.55	0.00
		50	88.00		
		43	102.33		
		$6.1C^{1.0}$	721.30		
Average Cu	231.99	41.9	5.54	16.32	0.00
		50	4.64		
		43	5.40		
		$6.1C^{1.0}$	38.03		

1 Lowest value dropped

2 Percolation volume per square foot is 0.4592 ft³/year

3 Aquifer volume passing under 1 square foot is 57584 ft³/year

Sensitivity Analysis

Due to the age of the data used for these calculations, an analysis of sensitivity was performed. The parameters of transmissivity, hydraulic gradient and infiltration were varied one at a time while holding the others constant over a plus or minus two-fold range. The recalculated groundwater concentrations did not exceed the values originally calculated, except for an increase to 0.01 mg/l for copper when the infiltration was doubled. When all three parameters were assigned the extreme values for increasing groundwater concentration simultaneously, the total chromium increased from 0.01 mg/l to 0.04 mg/l and the arsenic to 0.02 mg/l. This analysis demonstrates that the groundwater concentrations due to percolation will not exceed drinking water standards as a result of worst case hydrologic parameter variation.

SUMMARY

This report evaluated the potential for contamination of groundwater if the metals contaminated soil at the ferric chloride process rehabilitation area is left in place. On a qualitative basis, the site characteristics minimize the potential for leaching of the metals to the groundwater and the potential public health effects that may result. Quantitatively, the calculated increase in groundwater concentrations of these metals is negligible. In addition, the approach used in the calculations represents the worst case scenario. Prior to rehabilitation of the process, concrete pads and asphalt covering will be added to the area. Infiltration into the contaminated soil will actually be close to zero, and an increase in groundwater concentrations of these metals would be nonexistent.

In view of the data collected to date and the results of this evaluation, rehabilitation of the ferric chloride process as planned without remediation of the contaminated soil will not jeopardize ground water quality. A benefit of proceeding with rehabilitation without remediation of the proposed process area is the speed with which this may be implemented. The possibility of continued deterioration of the current storage tanks and release of their contents to the environment will therefore be minimized in accordance with the consent agreement.

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APPENDIX A

Calculations

A. Data Collected August, 1985

1. Average Transmissivity = 39733 gpd/ft
2. Aquifer Depth = 40 feet
3. Groundwater Elevations
 - a. MW 4: 105.16 ft
 - b. MW 8: 106.86 ft
 - c. MW 10: 106.94 ft

B. Existing Site Plan - October, 1989

1. Groundwater Well Locations
 - a. MW 4: 0, 0 ft
 - b. MW 8: 72, 0 ft
 - c. MW 10: 40.5, 45.75 ft

2. Surface Area of Proposed Rehabilitation Area = 4242 ft²

C. Calculation of Hydraulic Gradient

Equation for a line passing through three points:

$$z = ax + by + c$$

Where: $a = [(z1-z3)(y1-y2)-(z1-z2)(y1-y3)]/[(x1-x3)(y1-y2)-(x1-x2)(y1-y3)]$
 $b = [(z1-z3)(x1-x2)-(z1-z2)(x1-x3)]/[(x1-x2)(y1-y3)-(y1-y2)(x1-x3)]$
 $c = z$ when $x = 0, y = 0$
 x = Well location in an arbitrary x,y grid: x1: MW4, x2: MW8, x3: MW10
 y = Well location in an arbitrary x,y grid: y1: MW4, y2: MW8, y3: MW10
 z = Groundwater elevation: z1: MW4, z2: MW8, z3: MW10

Solving the equations yield:

$$z = 0.0236x + 0.0180y + 105.16$$

The magnitude of the hydraulic gradient vector is:

$$\begin{aligned} \text{grad} &= [vx^2 + vy^2 + vz^2]^{0.5} \\ &= 0.0297 \end{aligned}$$

Where: $vx = a$
 $vy = b$
 $vz = 0$

D. Hydraulic Conductivity

$$K = (T/b)/7.48 \text{ gal/ft}^3 \\ = 132.80 \text{ ft/day}$$

Where: K = Hydraulic conductivity (ft/day)
T = Transmissivity
b = Aquifer depth

E. Specific Discharge

$$q = -K * \text{grad} \\ = 3.94 \text{ ft/day}$$

Where: q = Specific discharge (ft/day)